

Image Quality Assessment For Amateur Photographer – Bachelor's Thesis

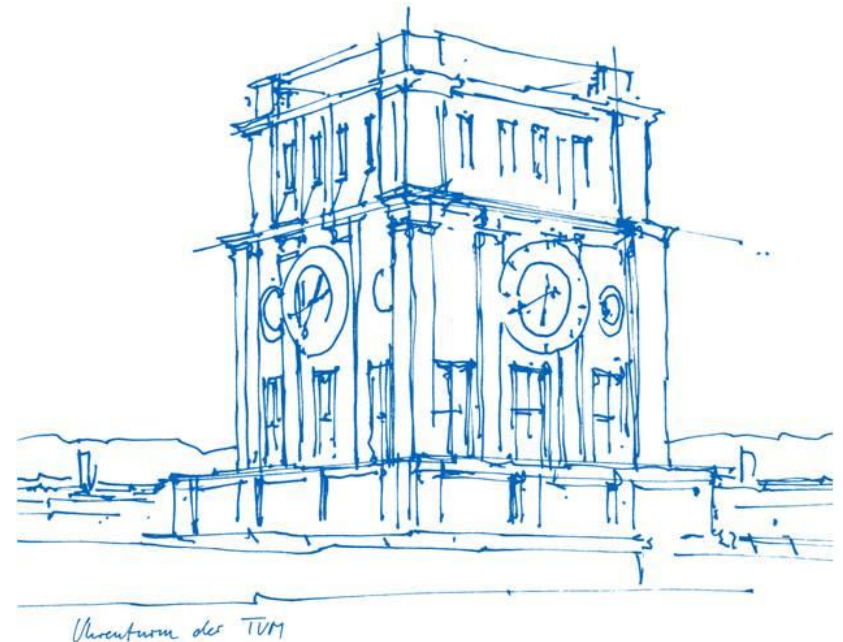
Lorenz Teply

Lehrstuhl für Datenverarbeitung

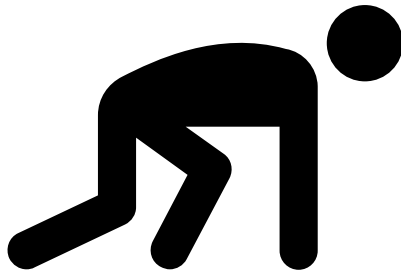
Fakultät für Elektro- und Informationstechnik

Technische Universität München

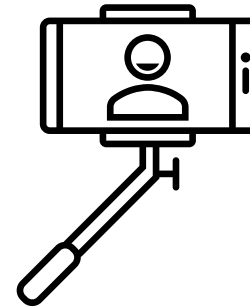
München, 23. Okt. 2020



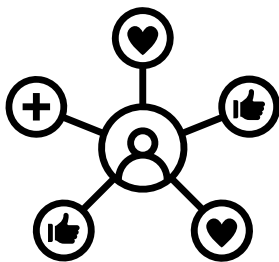
Content



Motivation



Datasets













Approach



Results

Motivation

- ▼  Photos (21 GB)
 - >  2014 (23 MB)
 - >  2015 (2.6 GB)
 - >  2016 (30 MB)
 - >  2017 (1 GB)
 - >  2019 (402 MB)
 - >  Archiv (1 GB)
 - >  Familie (1.7 GB)
 - >  Pi (1.3 GB)
 - >  **sortieren (12 GB)**

Motivation



Datasets

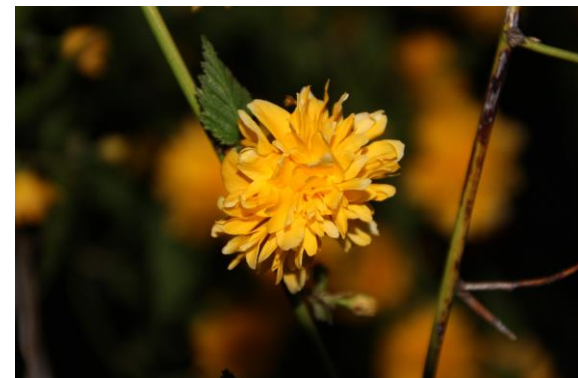
- Labeled to categories like:



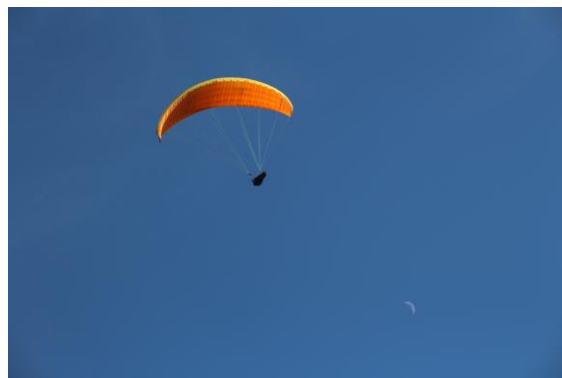
Animal



Landscape



Macro



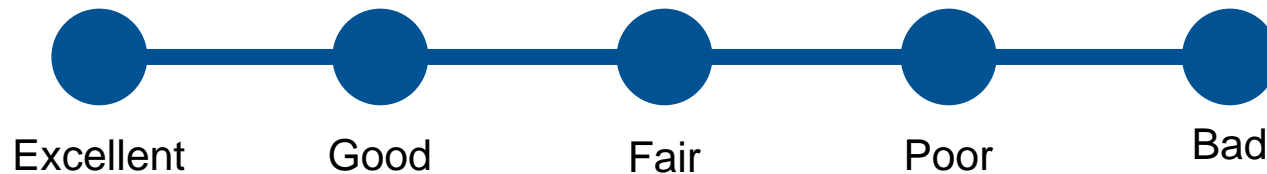
Other



Night

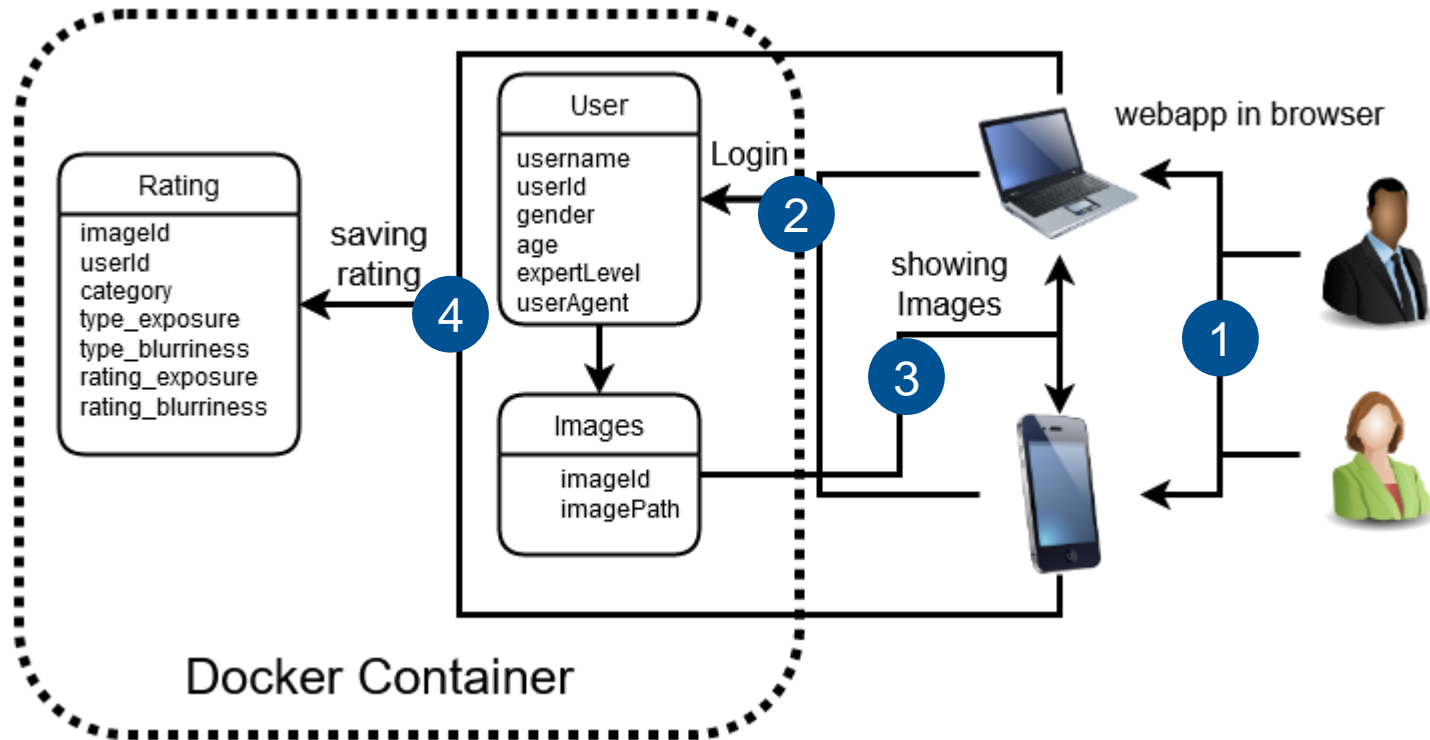
Datasets

- Labeled to categories like: Animal, Landscape, Macro, Night and Other
- Classification by type of exposure and blurriness
- Levels of exposure and focus rated on 5 steps **Mean Opinion Score (MOS)**



Datasets - Labelserver

- Publically reachable webserver



Datasets - Labelserver

- Publically reachable webserver
- Simple design
- Responsive Design



Image name: IMG_6083.JPG -- Progress: 2/40

Which category does the image have?

Portrait Sports Landscape Animal Macro Night Other

How would you evaluate the sharpness?
(Wie würden Sie die Schärfe betrachten?)

OK Out Of Focus Motion

How would you rate the image concerning sharpness?
(Wie würden Sie das Bild bezüglich der Schärfe bewerten?)

excellent good fair poor bad

How would you evaluate the exposure?
(Wie würden Sie die Belichtung betrachten?)

OK Over exposed Under exposed

How would you rate the image concerning exposure?
(Wie würden Sie das Bild bezüglich der Belichtung bewerten?)

excellent good fair poor bad

Selections CAN NOT BE REVERTED after clicking NEXT.
You have to select an option in each line before you can continue.

NEXT IMAGE

Datasets

Test Dataset



362 images



rated by one person



images from daily life and
specially made for finding
algorithm



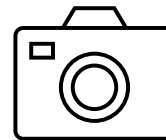
Verification Dataset



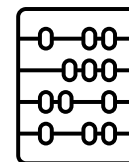
40 images



rated by 11 people



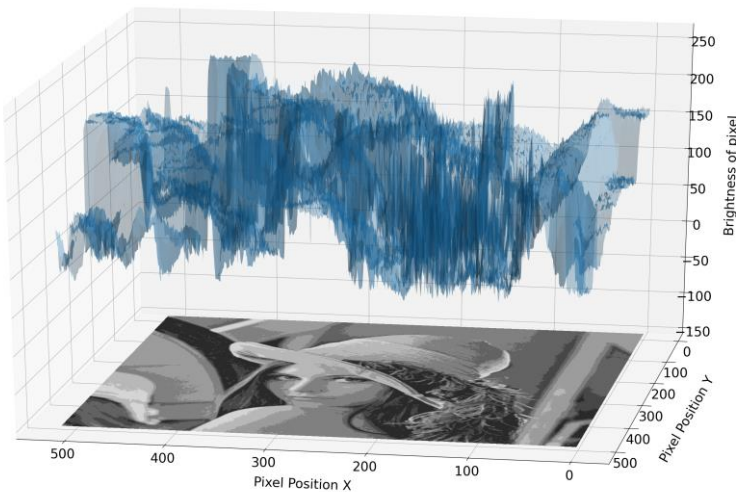
images from daily life



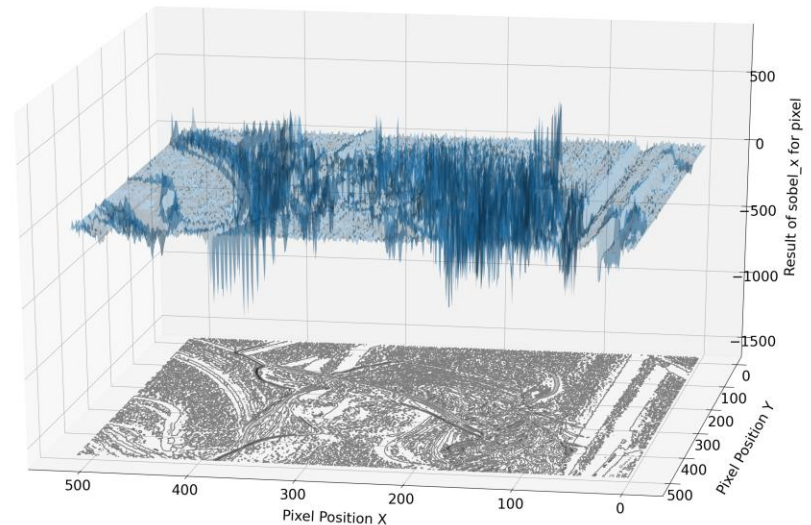
averages are taken

Approach

- Extracting features from grayscale images
 - Average Exposure
 - Percentage of dark and bright areas
 - Variance of Sobel, Scharr and Laplacian



Lenna in Grayscale



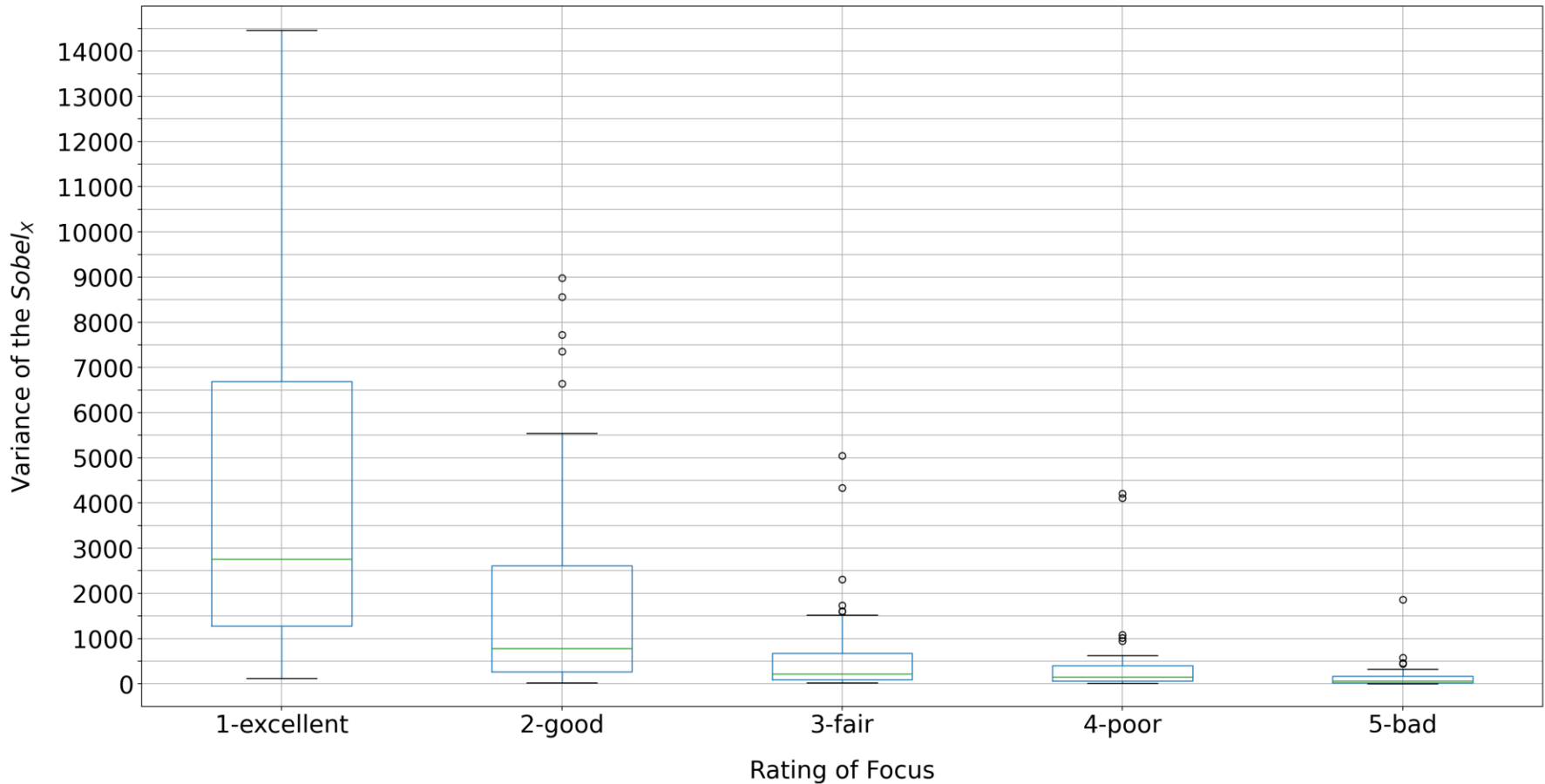
Lenna convoluted with the Sobel_x filter

Approach

- Understanding and defining image quality lowering factors
- Extracting features from grayscale images
 - Average Exposure
 - Percentage of dark and bright areas
 - Variance of Sobel, Scharr and Laplacian
- Determining Thresholds by prefer keeping possibly excellent over dropping bad images

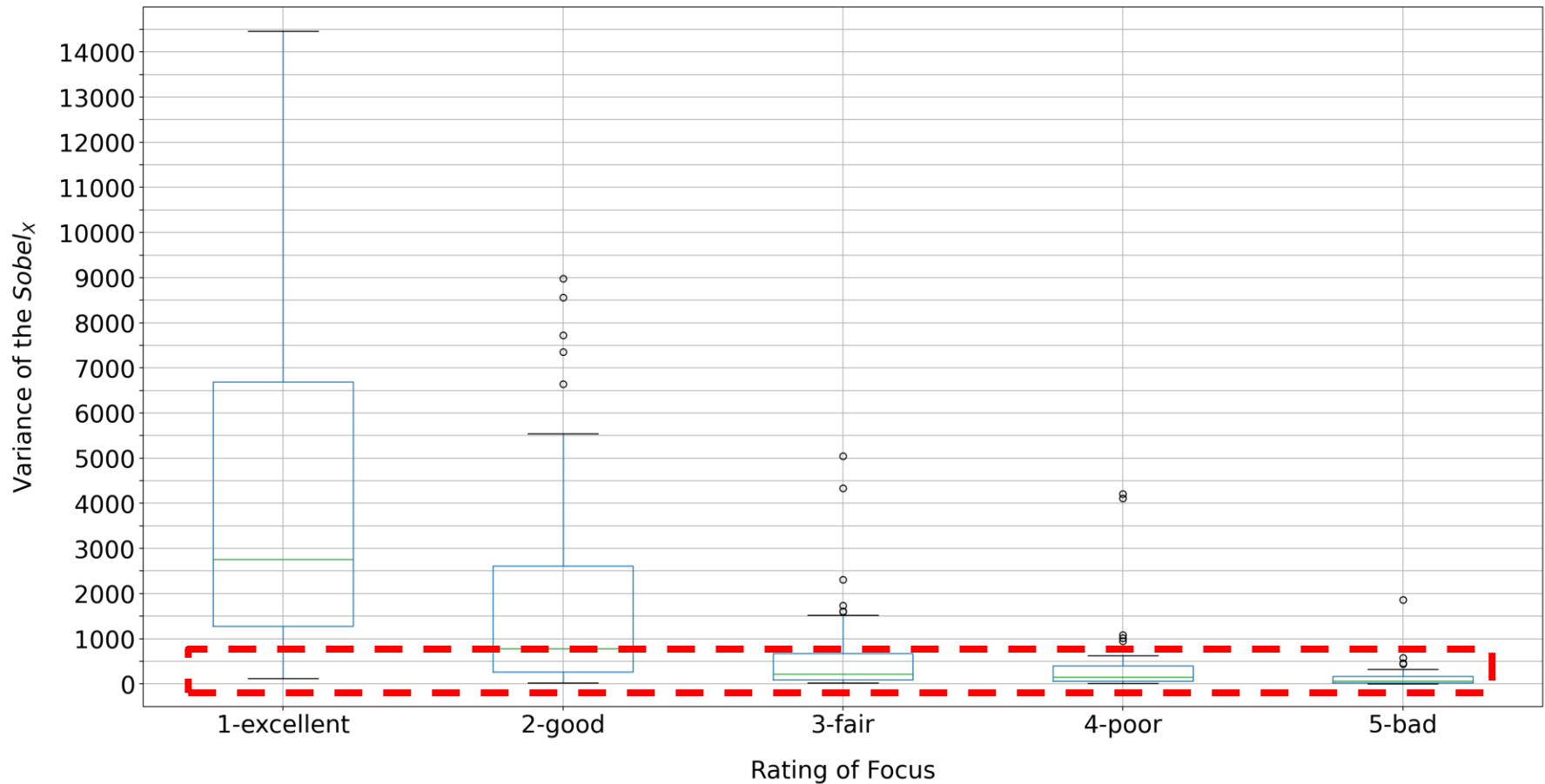
Approach – Determining Thresholds

Dataset with 362 images
(Values greater than 15000 are cutted)



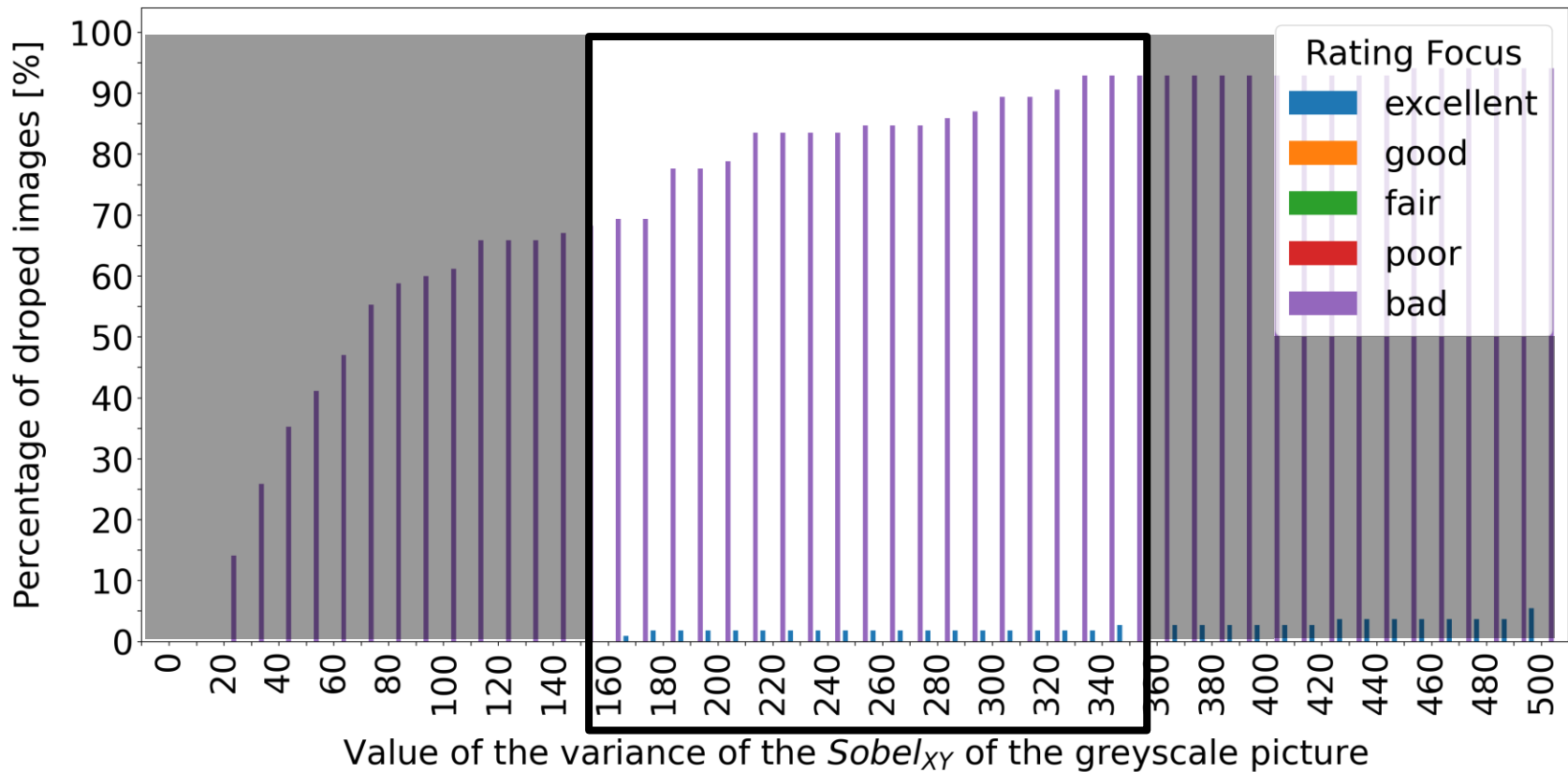
Approach – Determining Thresholds

Dataset with 362 images
(Values greater than 15000 are cutted)



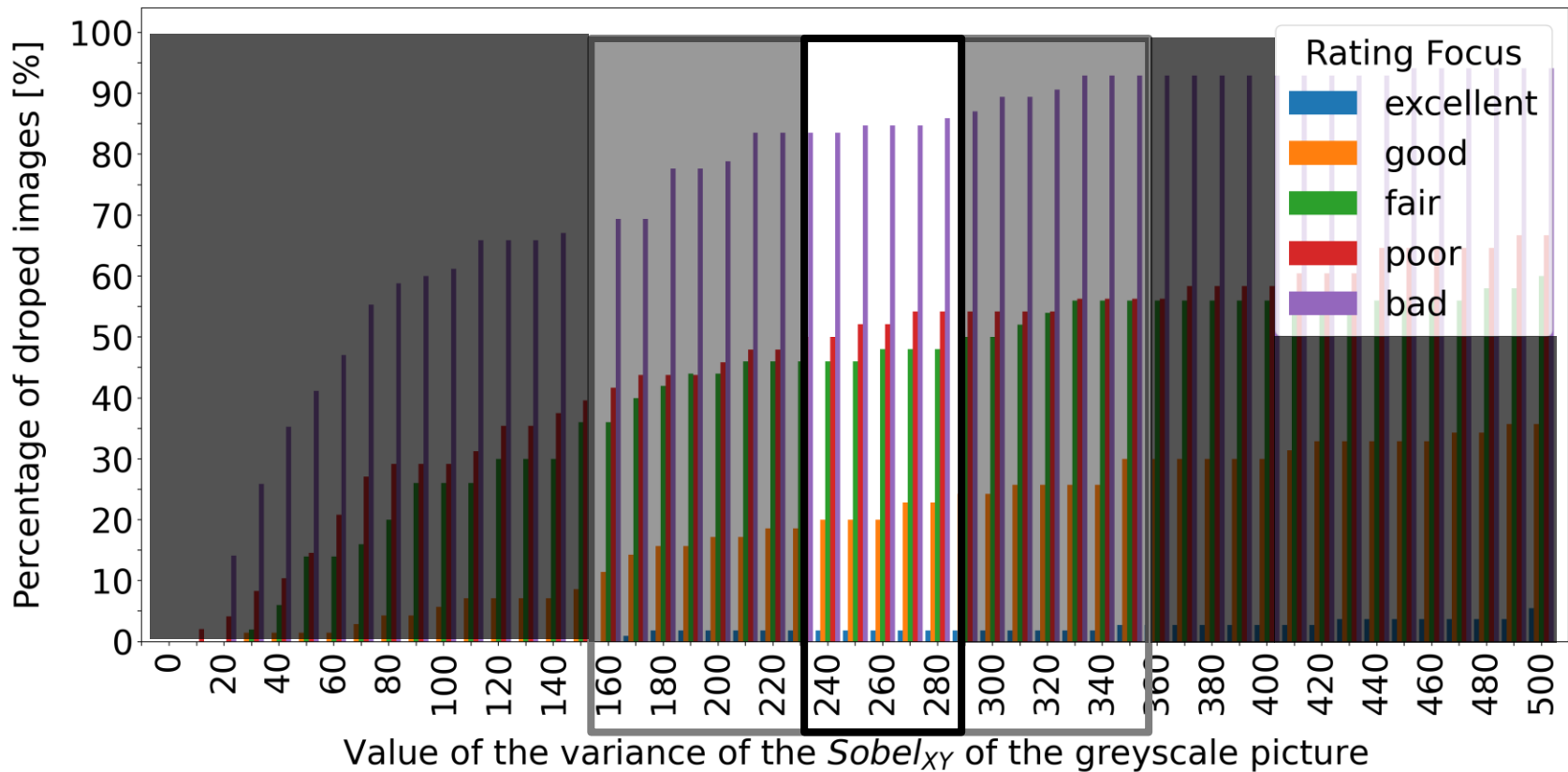
Approach – Determining Thresholds

Dataset with 362 images
Number processed images: excellent 109; good 70; fair 50; poor 48; bad 85



Approach – Determining Thresholds

Dataset with 362 images
Number processed images: excellent 109; good 70; fair 50; poor 48; bad 85



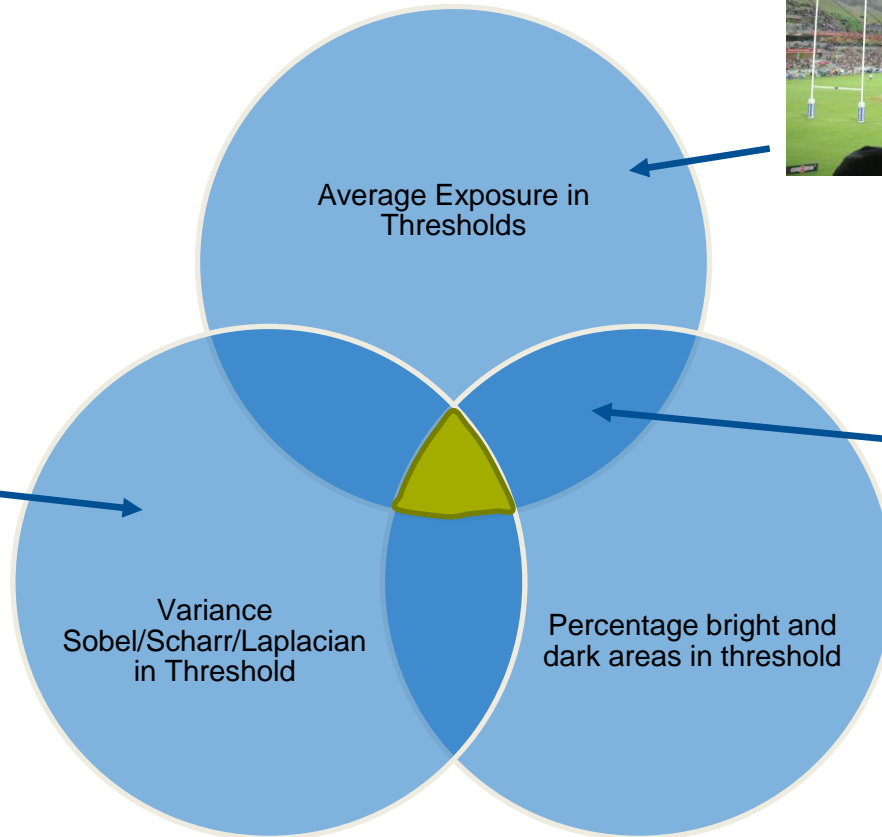
Approach

- Understanding and defining image quality lowering factors
- Extracting features from grayscale images
 - Average Exposure
 - Percentage of dark and bright areas
 - Variance of Sobel, Scharr and Laplacian
- Determining Thresholds by prefer keeping possibly excellent over dropping bad images
- Connecting Filter

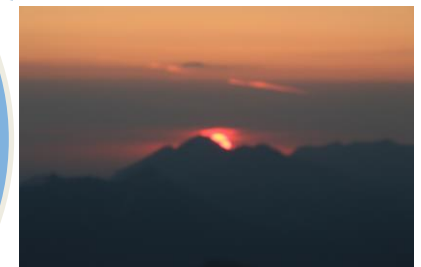
Approach – Connecting Filter



- ✗ Exposure
- ✓ Focus

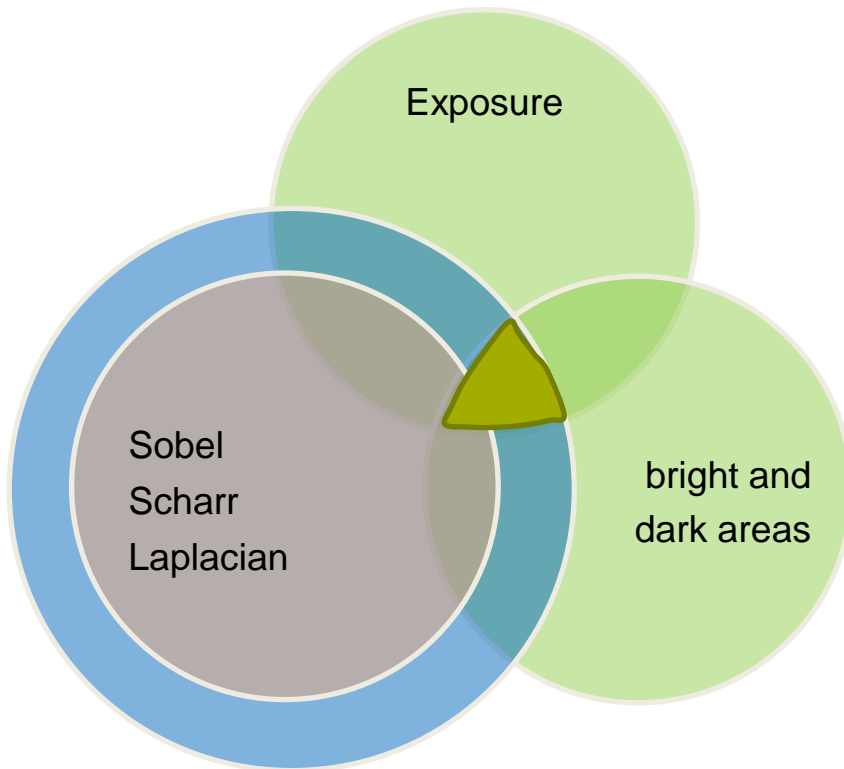


- ✓ Average
- ✗ Bright/Dark

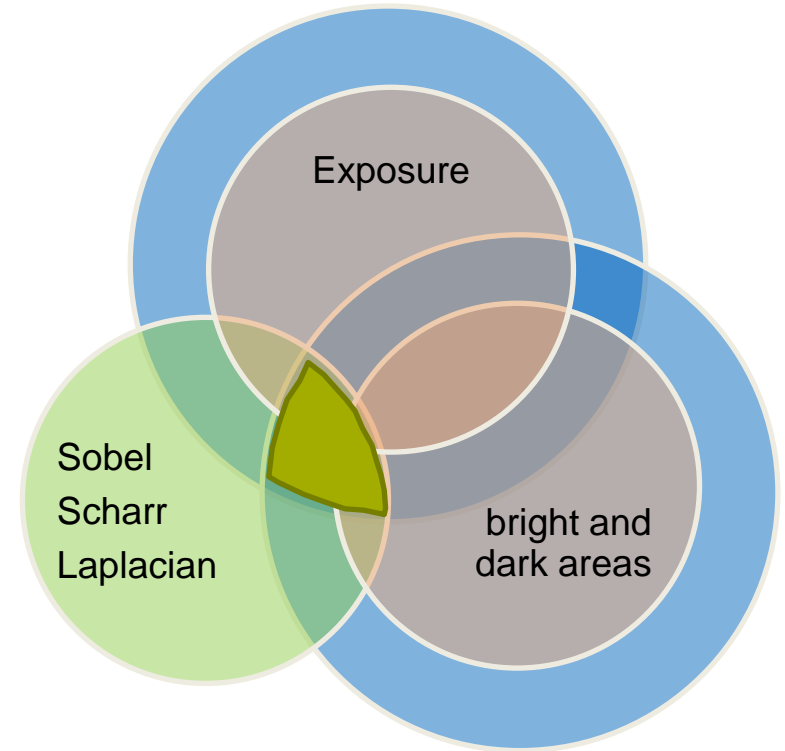


- ✓ Exposure
- ✗ Focus

Approach – „Containering“

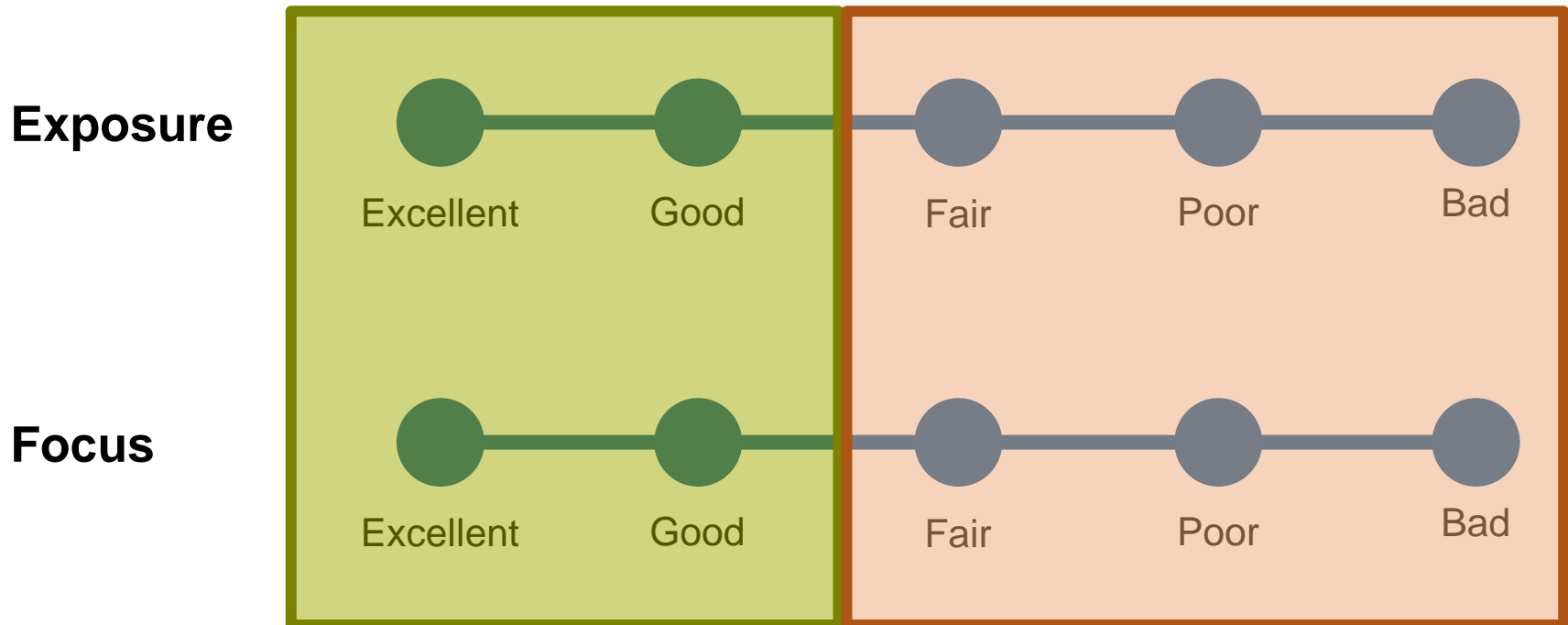


OR



Results

- Transformation of 5 score ratings into binary classification



Results

- Performance of Sobel and Scharr similar
- Performance of Laplacian slightly better than Sobel or Scharr
- Containering improves the performance by ~ 2%, especially Recall is improved
- F2 Score → higher weighting on Recall

Results – Confusion Matrices

Test Dataset – Laplacian with Containering

	Condition Positive	Condition Negative	<i>Precision</i>
Prediction Positive	96	71	0.5749
Prediction Negative	10	185	
<i>Recall</i>	0.9057		<i>F2: 0.8308</i>

Verification Dataset – Laplacian with Containering

	Condition Positive	Condition Negative	<i>Precision</i>
Prediction Positive	17	12	0.5862
Prediction Negative	4	7	
<i>Recall</i>	0.8095		<i>F2: 0.7417</i>

Results – Confusion Matrices

Verification Dataset: Recall 0.8; Precision 0.58; F2 Score 0.74

Pyimagesearch.com

	Condition Positive	Condition Negative	<i>Precision</i>
Prediction Positive	15	12	0.5556
Prediction Negative	6	7	
<i>Recall</i>	0.7143		<i>F2: 0.6757</i>

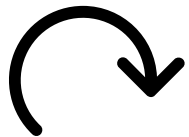
Gemini Photos

	Condition Positive	Condition Negative	<i>Precision</i>
Prediction Positive	21	18	0.5384
Prediction Negative	0	1	
<i>Recall</i>	1		<i>F2: 0.8536</i>

Results



Is detecting bad images reasonable













Categories to improve



Can reduce the workload, but not eliminate

Thank You For Your Attention

- ▼  Photos (21 GB)
 - >  2014 (23 MB)
 - >  2015 (2.6 GB)
 - >  2016 (30 MB)
 - >  2017 (1 GB)
 - >  2019 (402 MB)
 - >  Archiv (1 GB)
 - >  Familie (1.7 GB)
 - >  Pj (1.3 GB)
 - >  **sortieren (0 GB)**



Results – Additional Information

<u>Test Dataset</u>	Sobel	Sobel wC	Lapl.	Lapl. wC
<i>Precision</i>	0.7236	0.6242	0.5732	0.5749
<i>Recall</i>	0.8396	0.8774	0.8868	0.9057
<i>Balanced Accuracy</i>	0.8534	0.8293	0.8067	0.8142
<i>F2-Score</i>	0.7854	0.8116	0.818	0.8308

<u>Verification Dataset</u>	Sobel	Sobel wC	Lapl.	Lapl. wC
<i>Precision</i>	0.5714	0.5926	0.5652	0.5862
<i>Recall</i>	0.5714	0.7619	0.619	0.8095
<i>Balanced Accuracy</i>	0.5489	0.5915	0.5464	0.589
<i>F2-Score</i>	0.5682	0.7092	0.6052	0.7417

Approach – Additional Information

	Thresholds
<i>Scharr</i>	4200
<i>Sobel</i>	260
<i>Laplacian</i>	10
<i>Average (max)</i>	170
<i>Average (min)</i>	75
<i>Perc. Dark-Bright</i>	12

Test Dataset – Additional Information

	Animal	Landscape	Macro	Night	Other	Portrait
# images	12	77	35	5	227	6

Table 5.1: Test Dataset/Number by category

	OK	Motion	Out Of Focus
# images	226	39	97

Table 5.2: Test Dataset/Number by type of blurriness

	OK	Over Exposed	Under Exposed
# images	212	80	70

Table 5.3: Test Dataset/Number by type of exposure

	Excellent	Good	Fair	Poor	Bad
# images focus	109	70	50	48	85
# images exposure	57	127	59	36	83

Table 5.4: Test Dataset/Rating for level of focus and exposure

Verification Dataset – Additional Information

	gender	expert Level	platform
# persons	(5/6)	(1/0/7/3/0)	(5/6)

	Animal	Landscape	Macro	Night	Other	Portrait
# images	3	17	2	7	6	1

Table 5.6: Verification Dataset/Number by category

	OK	Motion	Out Of Focus
# images	32	2	6

Table 5.7: Verification Dataset/Number by type of blurriness

	OK	Over Exposed	Under Exposed
# images	28	6	6

Table 5.8: Verification Dataset/Number by type of exposure

	Excellent	Good	Fair	Poor	Bad
# images focus	10	21	2	6	1
# images exposure	9	17	9	5	0

Table 5.9: Verification Dataset/Rating for level of focus and exposure

F_β Score— Additional Information

$$F_\beta = (1 + \beta^2) \cdot \frac{\text{precision} \cdot \text{recall}}{(\beta^2 \cdot \text{precision}) + \text{recall}}$$

Sobel – Additional Information

Sobel The Sobel operator has kernels for the x and for the y derivative. The 3D kernels are reached by the the multiplication of the x- and y-derivative vector and the 1D Gaussian filter [6][9]. In the Sobel Kernel

$$Sobel_x = \underbrace{\begin{bmatrix} 1 \\ 2 \\ 1 \end{bmatrix}}_{1D Gaussian filter} * \underbrace{\begin{bmatrix} -1 & 0 & 1 \end{bmatrix}}_{X Derivative} = \begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix} \quad (4.1)$$

the Gaussian filter smooths the operation and due to this noise has less impact.

Scharr – Additional Information

Scharr The *Scharr* kernel is working similar to the *Sobel* kernel. The improvement is, that

$$\underbrace{\frac{1}{32} * \begin{bmatrix} -3 & 0 & 3 \\ -10 & 0 & 10 \\ -3 & 0 & 3 \end{bmatrix}}_{Scharr_x} \quad \text{and} \quad \underbrace{\frac{1}{32} * \begin{bmatrix} 3 & 10 & -3 \\ 0 & 0 & 0 \\ 3 & 10 & -3 \end{bmatrix}}_{Scharr_y} \quad (4.2)$$

are maximally optimized concerning the rotational symmetry of the Gradient [12].

Laplacian – Additional Information

The discrete Laplacian operator

$$[12] \quad \textit{Laplacian} = [1 \quad -2 \quad 1] + \begin{bmatrix} 1 \\ -2 \\ 1 \end{bmatrix} = \underbrace{\begin{bmatrix} 0 & 1 & 0 \\ 1 & -4 & 1 \\ 0 & 1 & 0 \end{bmatrix}}_{\textit{Laplace filter}} \quad (4.3)$$

in the second dimension is approximating the second derivative of the image pixel values. The application on Lenna can be seen in fig. 4.4.

Variance – Additional Information

The variance

$$VAR_{SOB_x} = \sum_x \sum_y \left[|S_x(x, y)| - \bar{S} \right]^2 \quad (4.4)$$

takes both together in account. The equation subtracts the mean

$$\bar{S}_x = \frac{1}{XY} \sum_x \sum_y |S_x(x, y)| \quad (4.5)$$

from

$$|S(x, y)| \quad (4.6)$$

as the absolute value of the result after the *Sobel* kernel was convoluted over the image. By the definition of the variance each summand is squared.